TRANSACTIONS
OF THE
ROYAL SOCIETY OF NEW ZEALAND

ZOOLOGY

VOL. 6 NO. 24 MAY 28, 1965

The Distribution of Echinoderms Along the East Coast of New Zealand

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[*Received by the Editor, 2 November 1964.*]

SINCE the publication by the writer of an article on distribution patterns of New Zealand echinoderms (Pawson, 1961), Dell (1962) has reviewed the status of New Zealand marine provinces in the light of some additional knowledge of the distribution of New Zealand molluscs. Dell (1962) notes that many mollusc species previously regarded as "typical" of the provinces defined by Finlay (1925) do in fact have a wider distribution than formerly supposed, and he discards the molluscan provinces, rather envisaging the Mollusca as being composed of three groups, namely:

1. A group extending throughout New Zealand.
2. A group essentially northern in origin.
3. A group essentially southern in origin.

Dell (1962, p. 50) suggests that more work should be concentrated on compiling full distribution data for all species, rather than attempting to define "rather nebulous province boundaries".

In response to this suggestion, a more detailed analysis is given here of the distribution of echinoderms along the east coast of New Zealand. Distribution data for the elements in the fauna have been derived chiefly from publications by Mortensen (1921–1925), Fell (1949a, 1949b, 1952, 1953a, 1958, 1960), Pawson (1963) and others, together with some data as yet unpublished.

At the present time, 215 species of echinoderms are known from the coasts of New Zealand. The east coast, an area which has been more intensively sampled than the west, supports a known fauna of 210 species. Thus, only five of the New Zealand echinoderm species are unknown from the east coast; of these, four have been recorded only from the south-western coast of the South Island, while the other has a bathyal distribution, and is expected to occur in east coast waters.

The accompanying figure (Fig. 1) shows some typical horizontal distributions of stenobathic shelf species. In the following text, the number parenthesised following the species mentioned refers to the number given the species in the figure.

Published by the Royal Society of New Zealand, c/o Victoria University of Wellington, P.O. Box 196, Wellington.

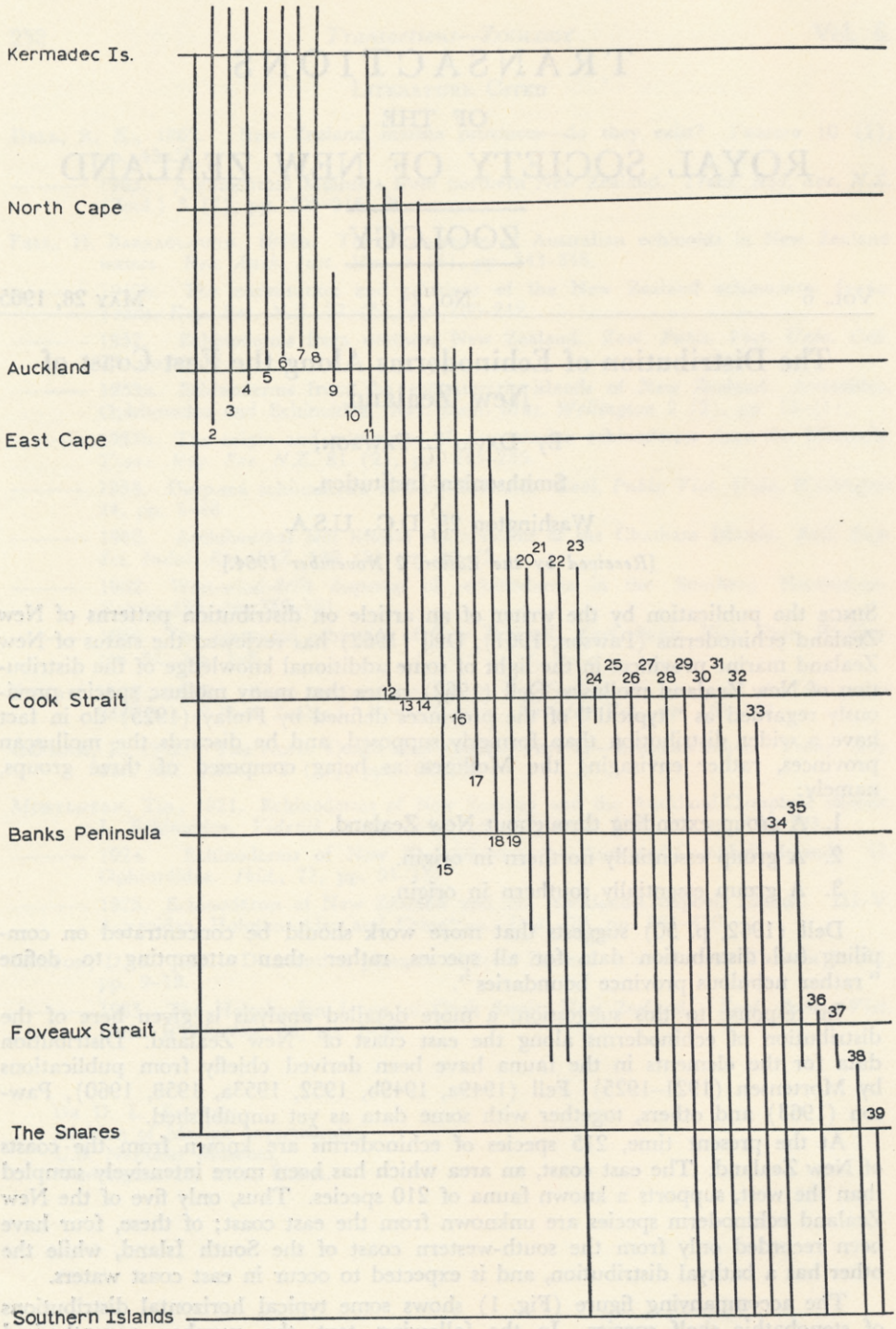

Fig. 1.—Horizontal distribution of stenobathic shelf echinoderms along the east coast of New Zealand. Key: 1, an assemblage of 13 species which ranges the entire east coast; 2, *Astropecten polyacanthus*; 3, *Ophiocentrus pilosa*; 4, *Asterodiscus truncatus*; 5, *Holopneustes inflatus*; 6, *Heliocidaris tuberculata*; 7, *Centrostephanus rodgersii*; 8, *Laganum depressum tonganense*; 9, *Brissus gigas*; 10, *Luidia varia*; 11, *Ophidiaster kermadecensis*: 12, *Pectinura cylindrica*; 13, *Ophiozonoida picta*; 14, *Ophioceres huttoni*; 15, *Stegnaster inflatus*; 16, *Amphiura rosea*; 17, *Ophiopteris antipodum*; 18, *Heterothyone ocnoides*; 19, *Astrostole scabra*; 20, *Stolus huttoni*; 21, *Pentagonaster pulchellus*; 22, *Asterodon miliaris*; 23, *Pseudechinus novaezealandiae*; 24, *Hemilepis abernethyi*; 25, *Eurygonias hylacanthus*; 26, *Neothyonidium dearmatum*; 27, *Pectinura maculata*; 28, *Asterodon dilatatus*; 29, *Apatopygus recens*; 30, *Monamphiura magellanica*; 31, *Calvasterias suteri*; 32, *Trochodota dunedinensis*; 33, *Amphioplus basilicus*; 34, *Paranepanthia aucklandensis*; 35, *Psolidiella nigra*; 36, *Trachythyone amokurae*; 37, *Ophionephthys stewartensis*; 38, *Pseudopsolus macquariensis*; 39, *Pseudocnus leoninoides*. Those species known from but a single record are not included.

SHELF FAUNA

The east coast shelf supports an echinoderm fauna of 145 species, representing 92 genera. Presumed stenobathic species restricted to the shelf number 83 (56 genera). The stenobathic shelf species thus represent about 58% of the total shelf fauna. This percentage might possibly be a little higher as there are some species which, while generally regarded as restricted to the shelf, have been taken from deeper waters; these include *Pentagonaster pulchellus, Heterothyne alba, Stichopus mollis* and *Chiridota nigra.* There is some evidence that specimens of these species may have accidentally fallen from the shelf into the bathyal depths in which they were found (Fell, 1958; Pawson, 1963).

Speciation is not far advanced in the stenobathic echinoderm fauna except in a few genera such as the widespread holothurian, *Chiridota,* which has five species in New Zealand.

The generic content of this fauna indicates strong affinities with the Indo-west-Pacific region, and the number of endemic genera is small. It is probable that the bulk of the fauna was ultimately and recently (in the geological sense) derived principally from the Indo-west-Pacific region. At the specific level, the situation becomes rather more complex. Of the eighty-three stenobathic shelf species 70 (83%) are endemic; 12 (15%) have warmer-water distribution (especially in Australia), and 2 (3%) are circumpolar. Here there are no true cosmopolitan elements; most of the cosmopolitan species in the echinoderm fauna of New Zealand are eurybathic forms.

The high percentage of endemic species needs no further discussion here, as this is a characteristic of the shallow water fauna of New Zealand, implying some isolation from adjacent land-masses.

The two circumpolar elements are *Ocnus calcareus* and *Monamphiura magellanica* (30), both of which are commonly found in the holdfasts of seaweeds—e.g., *Macrocystis.* Transport in the epiplankton with the aid of the west-wind drift has been suggested to account for the distribution of species such as these (Mortensen, 1925; Fell, 1953b). Recently, Fell (1962) has elaborated this theory on a quantitative basis.

There remain for consideration twelve "immigrant" species, which are known from the Australian-Indo-Pacific region, and warmer northern waters. Two of these species, *Allostichaster polyplax* (1) and *Coscinasterias calamaria* (1) are widely distributed along our coasts. The other ten species have what appears to be a restricted distribution off the east coast of New Zealand. They are:

Luidia varia (10)

Astropecten polyacanthus (2)

Ophidiaster kermadecensis (11)

Asterodiscus truncatus (4)

Ophiocentrus pilosa (3)

Centrostephanus rodgersii (7)

Heliocidaris tuberculata (6)

Holopneustes inflatus (5)

Laganum depressum tonganense (8)

Brissus gigas (9)

The last endemic species on the list, *Brissus gigas*, is very closely related to *B. latecarinatus*, an Indo-Pacific species. None of the above species has been taken from further south than East Cape. It is clear that the warmer-water elements in the stenobathic shelf echinoderm fauna have entered from the north, and the greater proportion of these "immigrants" appear to be remaining north of East Cape. The area north of East Cape is notable for the presence of these ten species, and thus differs faunistically from the remainder of the New Zealand shelf region. Together with these species are some endemic forms, including *Astropecten dubiosus* and *Vaneyothuria neozelanica*, which have a restricted distribution. (The latter species is New Zealand's sole representative of a large tropical and subtropical family of holothurians, the Holothuriidae).

It is concluded that the East Cape region constitutes a most important barrier to southward movement of some echinoderm species. Pawson (1961) has already discussed some physical factors which may contribute to the formation of this barrier. As a result of the southward flow of the East Auckland Current a counterclockwise swirl is established in the Bay of Plenty, and this should have some effect on the plankton of the area, tending to carry it away from East Cape rather than towards it. In this context it should be noted that many of the Australian-Indo-Pacific species known from north of East Cape have planktonic larval stages. The East Cape region may perhaps be interpreted as a "filter" zone, with the pattern of the coastal currents dictating the spread of species. Dell (1963) notes that some northern archibenthal (bathyal) molluscs are not yet known south of East Cape, and considers that this may later prove to have some significance, when more intensive sampling has been carried out.

Together with this immigrant fauna, there is an assemblage of 13 stenobathic species which range from the northern part of New Zealand to the southern part of the South Island, in some cases as far south as the Snares and the other southern islands. These are:

Patiriella regularis
Allostichaster polyplax
Stichaster australis
Coscinasterias calamaria
Ophionereis fasciata
Monamphiura spinipes
Monamphiura alba
Amphiura amokurae
Evechinus chloroticus
Ocnus calcareus
Protankyra uncinata
Trochodota dendyi
Kolostoneura novaezealandiae

The above assemblage is represented in Fig. 1 by number (1).

South of East Cape, the shelf fauna assumes a different aspect. Its most notable features include the presence of some southern species, virtual absence of stenobathic northern immigrants, and an overlap of endemic species which have either a northern or a southern distribution within New Zealand, but whose individual ranges do not embrace the entire coast. In addition, there are restricted stenobathic species such as *Eurygonias hylacanthus* (25), *Heterothyone ocnoides* (18), *Neothyonidium dearmatum* (26), *Astrostole scabra* (19), *Stolus huttoni* (20), and peak population of rather more widespread species, such as *Psilaster acuminatus, Persephonaster neozelanicus* and *Pentadactyla longidentis.*

It should be noted that the Cook Strait area is an important region of overlap of northern and southern species, giving its fauna a "mixed" aspect. Cook Strait itself appears to present no barrier to northward migration of southern species. Southern elements in the Cook Strait area include *Monamphiura magellanica* (30), a circumpolar species, *Asterodon dilatatus* (28) known from the Snares Island north to Cook Strait, *Amphioplus basilicus* (33), *Calvasterias suteri* (31), both recorded from the southern islands north to Cook Strait. Northern elements include *Stegnaster inflatus* (15), *Ophiozonoida picta* (13), *Ophioceres huttoni* (14), *Pectinura cylindrica* (12) and *Amphiura rosea* (16).

Further south, along the east coast of the South Island, the northern endemics tend to disappear, and a rather uniform southern group is encountered, especially towards the southern extremity of the South Island, in the Foveaux Strait region.

Foveaux Strait has an echinoderm fauna which resembles that of Cook Strait in some respects, both having many species in common, but Foveaux Strait differs in possessing the following features:

1. Presence of some species which are not known further north.

2. Peaking of populations in several species.

3. Impoverishment of some families which are well represented in the Cook Strait fauna.

4. Lack of a remarkable overlap of northern and southern species, a characteristic of Cook Strait.

The first three of the above features may now be discussed in more detail.

1. Presence of restricted species: *Ophionephthys stewartensis* (37) is known from Foveaux Strait and is unknown elsewhere. Of the two Foveaux Strait spatangids recently described by Fell (1963), *Spatangus thor* and *S. beryl*, the latter is as yet unknown from elsewhere, while the former has recently been taken from the Chatham Rise and south of New Zealand. *Pseudopsolus macquariensis* (38), a monotypic genus, is recorded from Stewart Island and Macquarie Island. *Trachythyone amokurae* (56) ranges from the Auckland Islands to Foveaux Strait. *Pseudocnus leoninoides* (39), a species previously known from the Auckland and Campbell Islands, is now recorded from the Snares, and is expected to occur in southern New Zealand.

2. Peaking of populations: It is true that Foveaux Strait and Cook Strait have many species in common, and straight lines indicating known limits of distribution show this, but such lines (as in Fig. 1) give no indication of population density. As yet, there are not enough data to make a satisfactory quantitative study of the fauna but it is known that for some species, the peak population lies in Foveaux Strait, with numbers of individuals falling off, either abruptly or

gradually, further north. *Apatopygus recens* (32) can be obtained in large numbers in Foveaux Strait, but off Oamaru, some 140 miles north of Foveaux Strait, only a single specimen has been collected by Graham (1962), and from Cook Strait, where the species is also known to occur, only approximately one dozen specimens have been taken. Similar declines have been noted in the abundance of *Asterodon dilatatus* (28), *Pseudechinus novaezealandiae* (23), *Goniocidaris umbraculum, Calvasterias suteri* (31), and *Pentagonaster pulchellus* (21).

3. Impoverishment of some Families: The family Ludiidae extends from North Auckland to south of Cape Campbell, while the Family Astropectinidae, for example, shows a marked reduction in number of representatives towards southern New Zealand. *Astropecten polyacanthus* (2) and *A. dubiosus* are northern species, *A. primigenius* ranges from North Auckland to east Otago, while *Psilaster acuminatus* and *Proserpinaster neozelanicus* tend to diminish in numbers south of Cook Strait.

The brief summary given above is intended to represent the present state of our knowledge of the distribution of New Zealand shelf echinoderms. This knowledge is still very lacunar, for there is yet much to be learned about the habits, vagility, and interrelationships of these shelf species.

BATHYAL (ARCHIBENTHAL) FAUNA

The bathyal echinoderm fauna comprises 100 species, which are distributed as follows: restricted species 57 (57%), Australian-Indo-Pacific 27 (27%), cosmopolitan 12 (12%), southern 4 (4%). The presence of 27 Australian-Indo-Pacific species points to that area as a source for many of our deeper water elements, as has already been pointed out by Fell (1953). The percentage of endemic species has dropped from 83% on the shelf to 57% on the slope, indicating the ability of the deeper water species to spread more widely. This archibenthal fauna may be subdivided into four categories:

1. Species common to shelf and slope: There are 35 of these species, of which seven (20%) are known from elsewhere.

2. Species common to the shelf, slope, and abyss: Of the 30 such species, 14 (46%) are endemic, but because of their eurybathic habit have achieved a wide distribution to the east of New Zealand. These include *Heteromolpadia marenzelleri* and *Ogmocidaris benhami.* Of the 16 species (54%) known from elsewhere, some have a very wide bathymetric range. *Ophiactis profundi* is known from 50–900 fathoms (90–1620 metres), *Molpadia violacea* from 20–700 fathoms (36–1260 metres) and *Paracaudina chilensis* from 0–750 fathoms (0–1350 metres).

3. Species common to slope and abyss: Twenty-four species fall into this category, and of these 18 (75%) are known from elsewhere. Of the six remaining species, four are known from one record each. In this category the Indo-west-Pacific influence is becoming overshadowed by more pan-Pacific and cosmopolitan elements, such as *Laetmogone violacea, Enypniastes eximia.*

(In the three categories listed above the percentage of immigrants is seen to rise from 27% through 54% to 75%, indicating how the fauna loses its "New Zealand character" with increase in depth.)

4. Species restricted to the bathyal zone: Eleven species are so far known only from the bathyal zone, and of these, two (18%) are known from elsewhere. They are *Cosmasterias dyscrita*, which is a wide-ranging species, and *Ophiacantha abyssicola*, a deep-sea species which is expected also to occur in our abyssal zone, thus falling into category 3 above. The remaining nine species (82%) are all known from but one record each, and thus they are not well enough known to be considered as restricted to the bathyal zone.

It seems evident that there is no restricted bathyal fauna as such; rather the fauna appears to be derived in part from the abyss and in part from the shelf. The bathyal zone fauna is mixed, reflecting an ascending and descending traffic. An example of an ascending species is *Spatangus multispinus*, which in Cook Strait is decidedly a deep-water form, reaching peak populations in abyssal depths. Occasional specimens taken from the shelf in Cook Strait almost certainly represent derivatives from a deep-water population living nearby. Descending traffic is exemplified by *Ophiocoma bollonsi*, which is represented by large local populations on the Cook Strait shelf, but a few specimens have been collected from depths in excess of 350 fathoms (630 metres).

CONCLUSIONS

Four facts emerge from the present study:

1. There are 13 species which occur along the entire east coast of New Zealand.

2. Of the 12 Australian-Indo-Pacific elements in the stenobathic shelf fauna, 10 are unknown from south of the East Cape region.

3. Between East Cape and the southern part of the South Island, the fauna shows an overlap of northern and southern endemics, together with circumpolar species.

4. The fauna of the Foveaux Strait region is notable for possessing the four characters already discussed above.

Three distinct faunal assemblages may therefore be recognized off the east coast of New Zealand—namely, a northern assemblage, a middle (mixed) assemblage, and a southern assemblage.

The areas characterised by these assemblages have previously been labelled "provinces" for the purposes of convenience, and the provincial faunal patterns of the echinoderms have been discussed by Fell (1949b) and Pawson (1961). Dell (1962) has analysed the use of the word "province" in relevant molluscan literature, and concluded that while the term has been defined by several people, the definitions given are often at variance, and in some cases almost mutually exclusive. Provinces must have boundaries, and these should be capable of definition, in terms of physical factors, which act in some way to prevent or restrict the movements or spread of certain species.

As the term "province" has unfortunate connotations, it seems desirable to discard it, but it is felt that in the case of the echinoderms, the three faunal assemblages of the New Zealand east coast shelf should be named. Finlay's (1925) terminology could be retained for historical and purely practical reasons, and the assemblages could be termed Aupourian (northern), Cookian (middle, mixed) and Forsterian (southern) faunas.

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